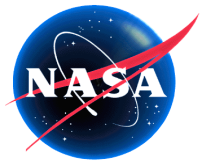

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Pasadena, California

AIRS Project Status

AIRS Science Team Meeting

October 14, 2008

Tom Pagano

California Institute of Technology
Jet Propulsion Laboratory

National Aeronautics and
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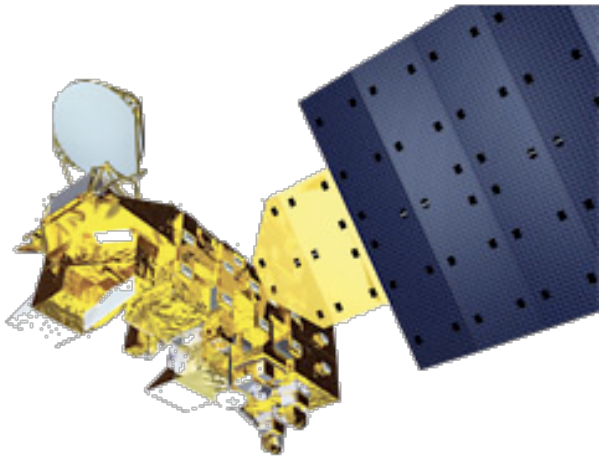
California Institute of Technology
Pasadena, California

Instrument and Spacecraft Status

- Instruments operating well. No problems.
  - High Calibration Accuracy, Extremely Stable
  - Performance Continues to be Excellent
  - Slight AIRS detector and cooler degradation with time being monitored
  - AMSU Channel 4 Failed; Channel 5 Degraded
  - An AIRS/AMSU-A anomaly resolution guide complete



- Aqua is in very good condition
  - Some minor power system anomalies have occurred since launch, but none have impacted instrument hardware or science data
  - A software anomaly in the solid state recorder, induced by operator error last December, remains unrepaired
    - A ground system workaround permits normal science data processing without any losses
  - Most important known limitation on lifetime is the fuel supply for spacecraft maneuvers
  - Present (conservative) estimates say fuel will last until 2016

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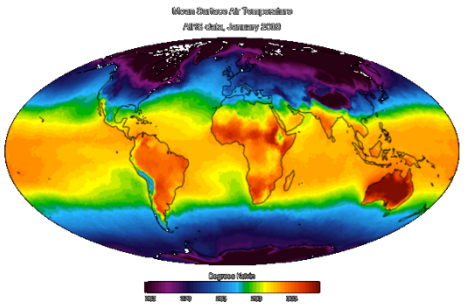
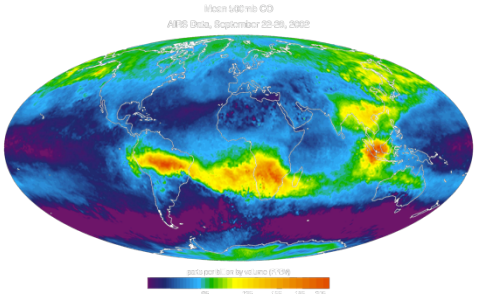
AIRS Science Products

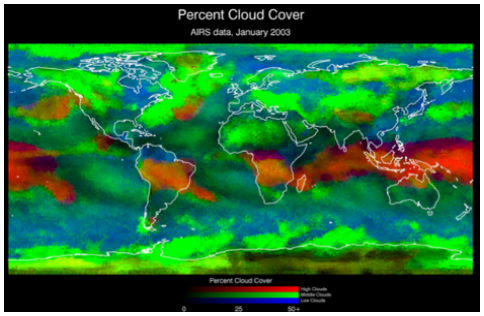
Atmospheric Temperature



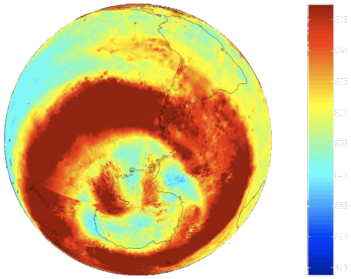
CO



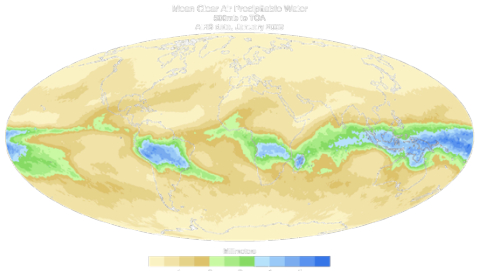
Cloud Properties



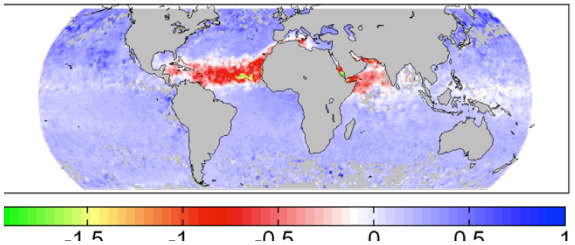
Ozone



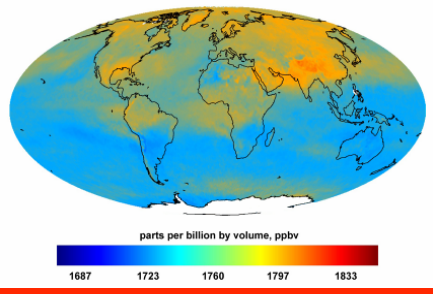
Atmospheric Water Vapor



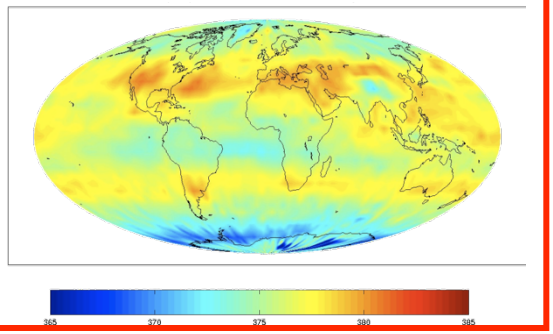
Dust



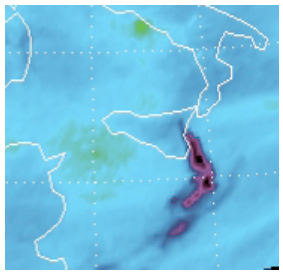
Methane



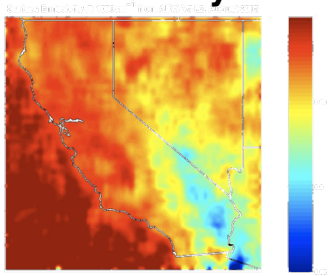
CO2



SO2



Emissivity



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Validation of Version 5 Core Products is Project Priority

Senior Review Requested Peer-Review of Validation Status of Standard Products By end of 2008

AIRS Product	Uncertainty Estimate (Version 5)	Val Status (Version 5)	Source
Radiances			
AIRS IR Radiance	<0.2%	Stage 3	Project
AIRS VIS/NIR Radiance	15-20%	Stage 1	Project
AMSU Radiance	1-3 K	Stage 3	Project
HSB Radiance	1-3 K	Stage 3	Project
Core Products			
Cloud Cleared IR Radiance	1.0 K	Stage 2	Project
Sea Surface Temperature	1.0 K	Stage 2	Project
Land Surface Temperature	2-3 K	Stage 1	Project
Temperature Profile	1 K / km	Stage 2	Project
Water Vapor Profile	15% / 2km	Stage 2	Project
Total Precipitable Water	5%	Stage 2	Project
Fractional Cloud Cover	20%	Stage 2	Project
Cloud Top Height	1 km	Stage 2	Project
Cloud Top Temperature	2.0 K	Stage 2	Project
Neccesary Products*			
Total Ozone Column	5%	Stage 2	Project
Ozone Profile	20%	Stage 2	Project
Land Surface Emissivity	10%	Stage 1	Project
IR Dust**	0.5 K	Stage 1	Project
Research Products			
Carbon Monoxide	15%	Stage 2	NOAA/UMBC
Methane	2%	Stage 1	NOAA
Carbon Dioxide**	1-2 ppm	Stage 1	NASA/NOAA
OLR	5 W/m2	Stage 1	GSFC
HNO3**	0.2 DU	Stage 1	NOAA/UMBC
Sulfur Dioxide**	1 DU	Stage 1	NOAA/UMBC

*Necessary Products are required to retrieve accurate temperature profiles (1K/km) in all condition

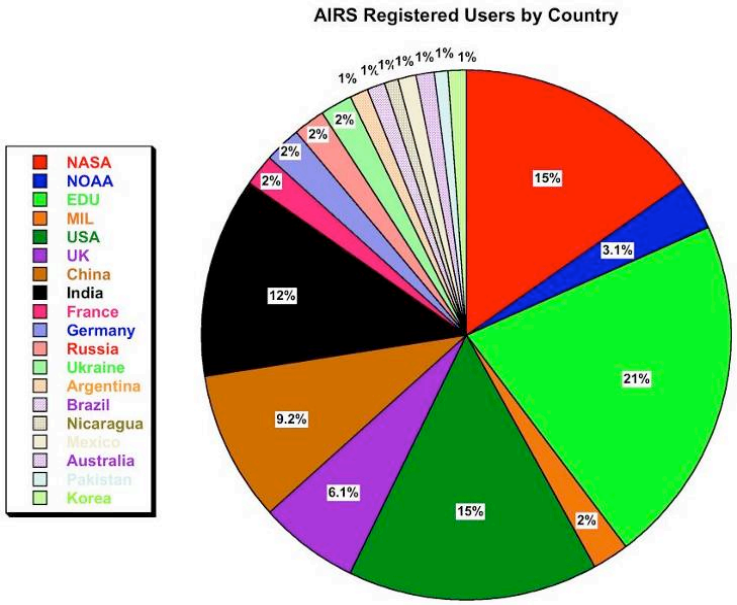
**Product not yet available in AIRS Level 2 Files. Products will be available in Version 6

NOAA NESDIS

GES/DISC (GSFC)

DIRECT BROADCAST

442 Registered Data Users (07/30/08)



<u>NWP Centers</u>
NCEP
CMC (Canada)
JMA (Japan)
FNMOC (US Navy)
BMRC (Australia)
UK Met Office
ECMWF (Europe)
Meteo-France
DWD (Germany)
CPC

- Universities
- SPoRT (Regional)
- Brazil (INPE)
- China
- Korea
- DoD
- Other International

star.nesdis.noaa.gov

daac.gsfc.nasa.gov

cimss.ssec.wisc.edu/imapp

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Version 5 Product Generation

- Version 5 Released to the Public: 07/25/07
  - Verification Report and User Documentation Complete
- AMSU Channel 4 Anomaly Resolution Complete
- GES/DISC Reprocessing for AIRS Complete
  - Processing with Version 5.0 Prior to October 1, 2007
  - Processing with Version 5.2 October 1, 2007 to Present
- All AIRS Data Available at
  - http://disc.sci.gsfc.nasa.gov/news/airs_v5_072507.shtml
- NOAA began processing with Version 5 during April 2008
- AIRS V5 Direct Broadcast code now available since July 2008 at:
  - http://cimss.ssec.wisc.edu/imapp/AIRS/AIRS_v5.2.html

6

Version 6 Priorities

- Level 1C Climate Product (New)
  - Remove Artifacts from L1B
- Level 2
  - Bias Trend Removal
  - Improve Boundary Layer Sensitivity
  - Retrieve Surface Emissivity
  - Yield Improvement in Critical Areas
  - Improve Error Estimation
  - RTA Improvement
  - Improve OLR computation
  - Cloud Retrieval Improvement
  - Retrieve Mid Tropospheric CO2
- Level 3
  - Reduce Sampling Bias Effects
- Validation Priorities
  - Validate all Version 5 Products

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Science Team Participation Critical to Version 6 Objectives

From 10/07 SciTeam Meeting

- Susskind (GSFC)
  - Surface Parameters (T, e)
  - Boundary Layer T, q
  - Trend Evaluations/ Recommendations
  - Improved Error Estimates and QC
  - Cloud/Dust Product Improvement
  - 1 x 3 Retrievals
- Strow (UMBC)
  - L1C Algorithm
  - RTA Scattering Algorithm
  - Additional RTA Tasks
    - Dust
    - Cirrus
  - OLR
- Blackwell (MIT)
  - SCC/NN Investigation
- Barnet (NOAA)
  - Bias Trends Removal
  - Cloud Clearing vs Warmest FOV
  - CO2
  - SO2 , CH4, HNO3, N2O,O3
  - CAPE, LI + Convective Products
  - 1x3 (NOAA Interest, SPORT, Forecasters, etc.)
- Goldberg (NOAA)
  - Initialization State (Regression Coefficients)
  - Maintain RT System
- Rosenkranz (MIT)
  - Updated MW RTA
- JPL
  - CO2 (Chahine)
  - Cirrus (B. Kahn)
  - L1C (H. Aumann)

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Survey Results
58 Participants

Ranking from Most Used to Least Used Products

Surface	Air Temp
	Skin Temp
	Emissivity
	Surface Pressure
Atmosphere	Temp Profile
	Specific Humidity Profile
	Relative Humidity Profile
	Total Precip Water
Composition	Ozone
	Carbon Dioxide
	Sulfur Dioxide
	Carbon Monoxide
	Methane
	Other
Clouds	Fraction
	Liquid H2O
	Top Temperature
	Aerosol/Dust
	Top Pressure
	Other

Level	Level 2
	Level 3
	Level 1B
	Level 4
Improve	Higher Accuracy
	Vertical Resolution
	Spatial Resolution
	Temporal Repeat
	Spectral Coverage
	Geospatial Coverage
	Spectral Resolution

Users Most interested in Improving Accuracy and Resolution Of Products

Participant Comments (1 of 2)

- (1) Suggest putting the quality info all in one place, i.e., the data files, rather than in separate files (i.e., data and calibration properties file). (2) Suggest making use of dimscales in the data files for the third dimension, i.e. channel frequency for L1, pressure level for L2, etc. [GES/DISC]
- Combined AIRS+MODIS and/or AIRS+CloudSat datasets would be useful- the idea is to use A-Train together, so more combined datasets would allow more combined-sensor studies related to clouds, aerosols, etc. [Unknown]
- NASA AIRS is providing essential information on the evolution of our atmosphere, which can not be obtained any other way. Furthermore, its value and importance as a legacy program from launch to present and future can not be over emphasized as we try to understand the anthropogenic influences on the atmosphere. The AIRS Team is doing a magnificent job. [NGA]
- Thank you for considering me. What I marked in this survey are good parameters for monitoring and calculating global warming variables such as heat accumulated in the surface, surface temperature rise, and sea level rise. Thank you again. Nabil Swedan
- I benefit a lot from your products. Thanks. [China]
- Thank you very much for AIRS data. [Ukraine]
- Continued…

Participant Comments (2 of 2)

- I'm just at the very beginning and looking for atmospheric data for radiation, convection, caloric input data. Thank you very much indeed! [Unknown]
- Thank you for your service [Unknown]
- It will be useful to concentrate on Cosmic ray variation and cosmic dust detection along with other components. [India]
- I've been a user of AIRS L2 NRT products for many months. I think the AIRS people are doing a wonderful job for providing the data accessible to the public, providing sample decoders, and providing answers to questions we have about the science and techniques of their products. Thanks [NOAA]
- I would like to thank you very much for your efforts to make these data available for the scientific community [Egypt]

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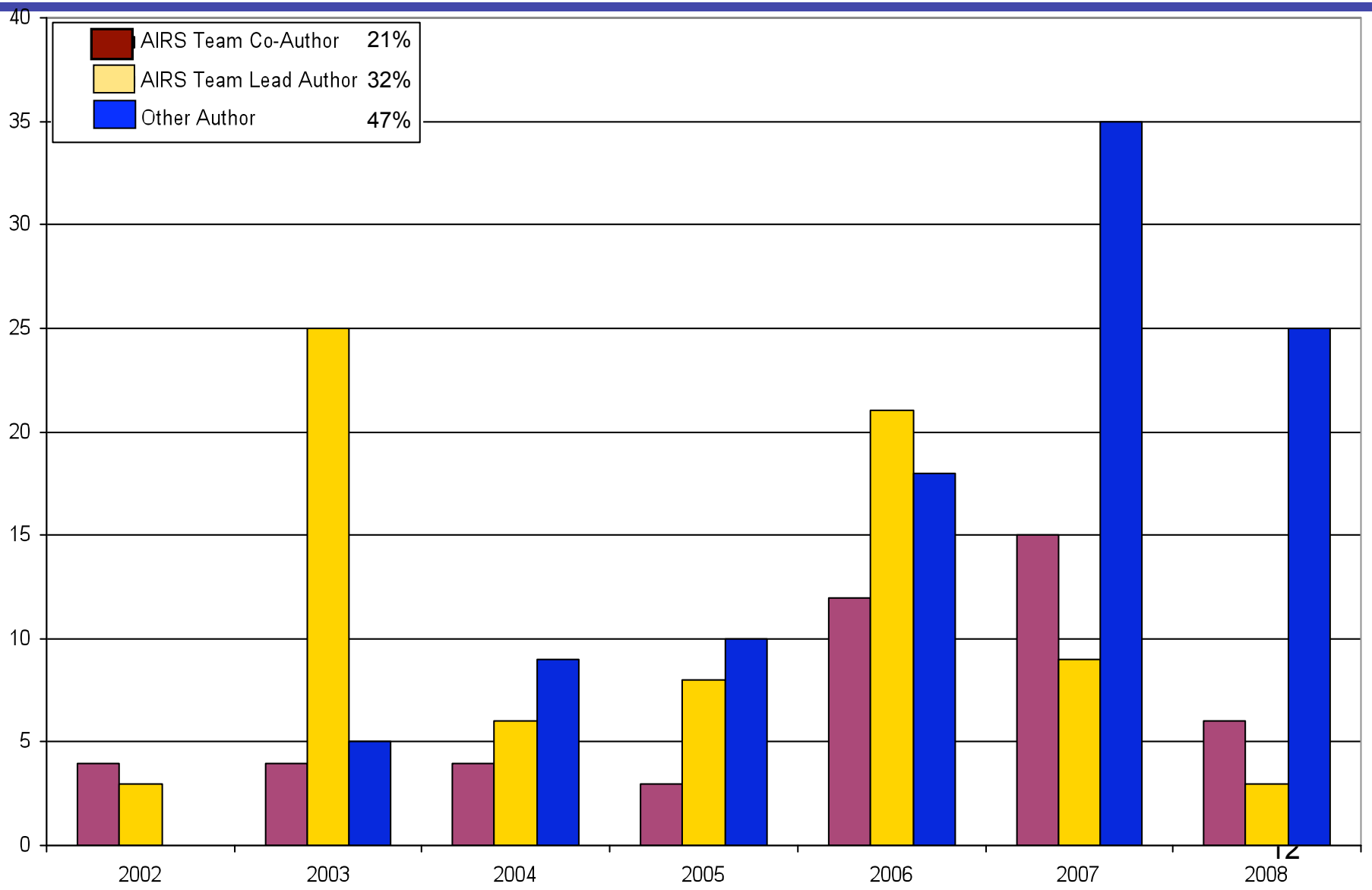
AIRS Peer-Reviewed Science Publications

(Publications Available as of 07/23/08; 222 Total, 19 since last Quarterly)



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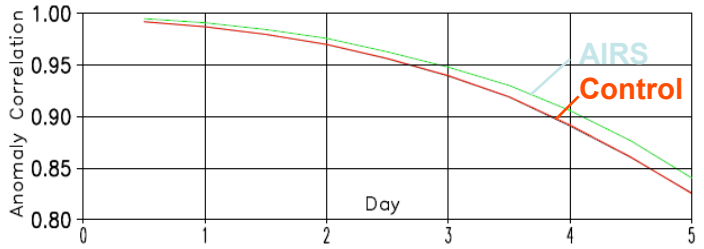
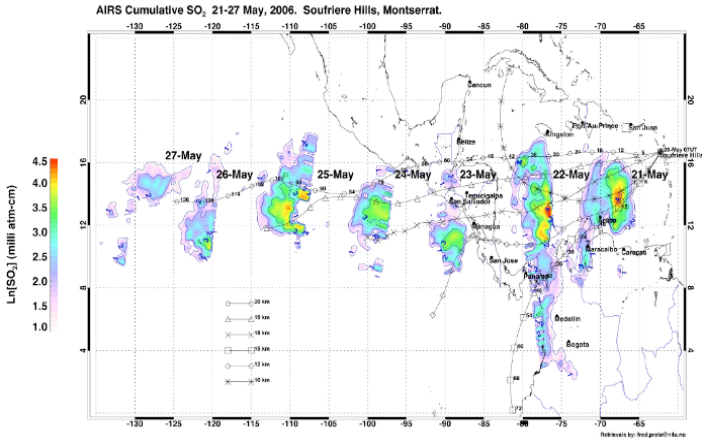
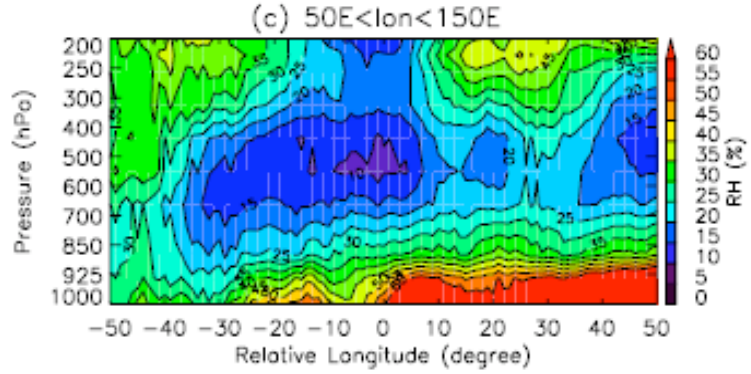
Recent AIRS Science Highlights (1 of 2)

- **Positive Forecast impact seen by assimilation of Temperature Profiles**
  - Improving forecast skill by assimilation of quality controlled AIRS temperature retrievals under partially cloudy conditions, O. Reale, J. Susskind, R. Rosenberg, E. Brin, E. Liu, L.P. Riishogjaard, J. Terry, J.C. Jusem, GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L08809, doi: 10.1029/2007GL033002, 2008
- **AIRS Used to Study long-range Transport of Volcanic SO2**
  - Long range transport and fate of a stratospheric volcanic cloud from Soufriere Hills Volcano, Montserrat, Prata, A.J., Carn, S. A., Stohl, A., Kerkmann, J., Atmospheric Chemistry and Physics, 2007, 7, 19, 5093-5103
- **AIRS Used to Study Upper Atmospheric Water** Vapor
  - Variability of subtropical upper tropospheric humidity, Ryoo, J.M., Waugh, D.W., Gettelman, A., Atmospheric Chemistry and Physics, 2008, 8, 2643-2655
- **Upper Tropospheric Clouds and SST**
  - Variations of tropical upper tropospheric clouds with sea surface temperature and implications for radiative effects, Su, H. et al, J. Geophys. Res., 113, D10211, doi: 10.1029/2007JD009624







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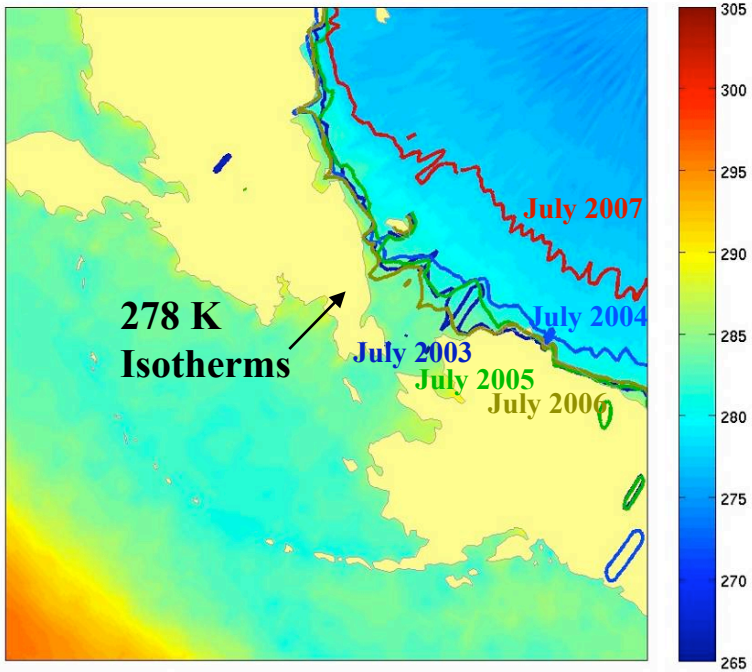
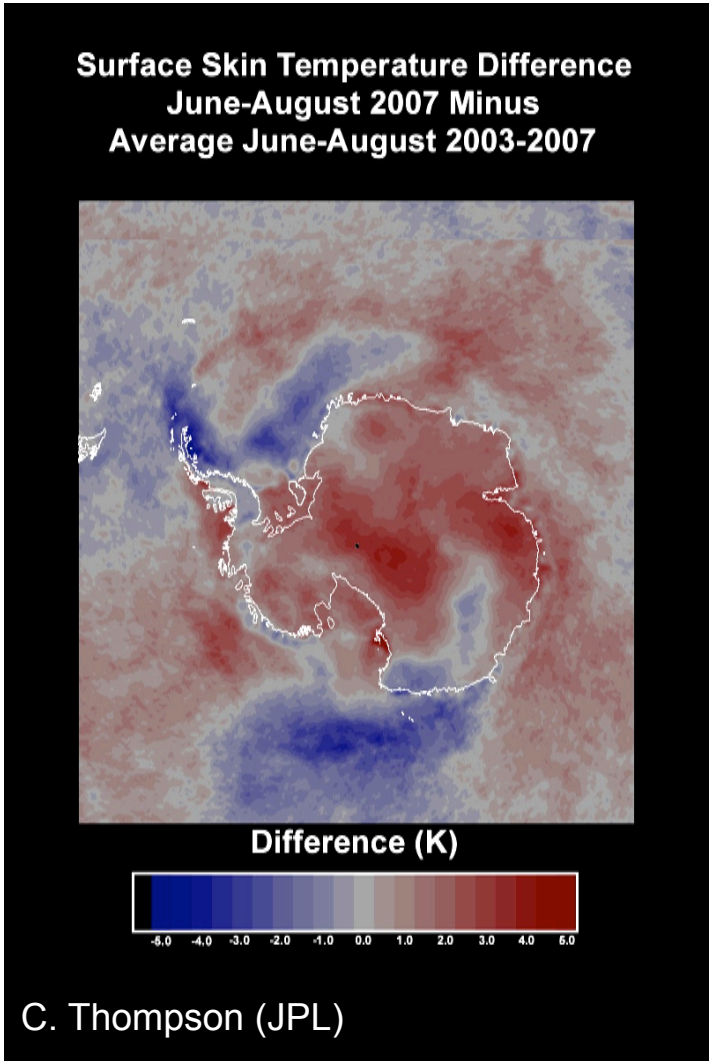
AIRS Detects Inter-annual Change in Polar Regions

Arctic Sea Ice Loss



T. Pagano

Antarctic Surface Temperature



C. Thompson (JPL)

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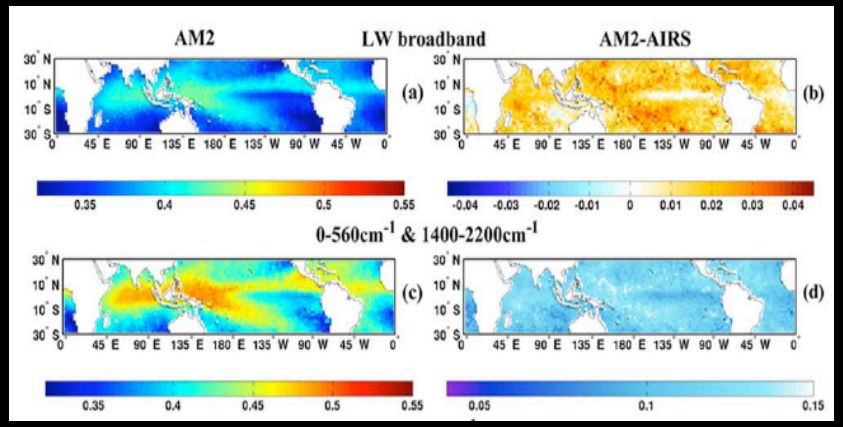
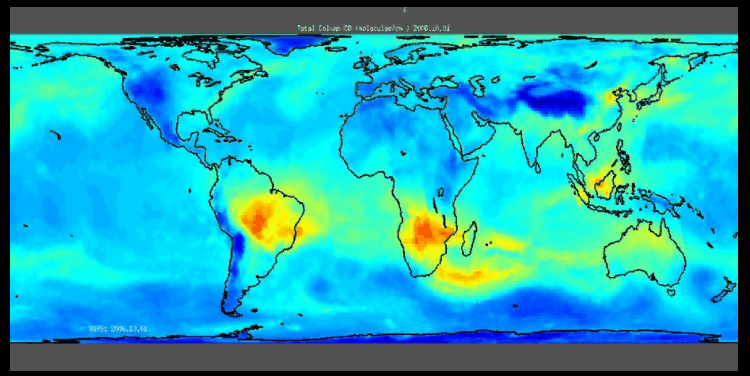
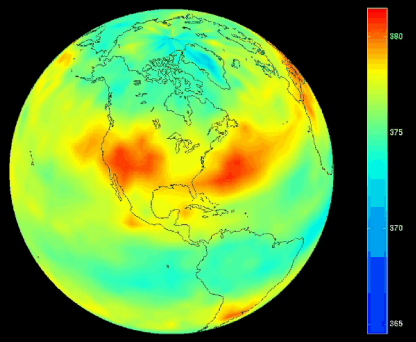
Recent AIRS Science Highlights (2 of 2)

- **AIRS OLR Resolves Partition of Energy**
  - Spectrally resolved fluxes derived from collacated AIRS and CERES measurements and their application in model evaluation: clear sky over the tropical oceans, Huang, X.L., Yang, W. Z., Loeb, N.G., Ramaswamy, V., Journal of Geophysical Research - Atmospheres, 2008, 113, D9, D09110
- **Global Carbon Monoxide Studies Continue**
  - Global AIRS and MOPITT CO measurements: Validation, comparison, and links to biomass burning variations and carbon cycle, Yurganov, L, N., McMillan, W.W., Dzhola, A.V., Grechko, E.I., Jones, N.B., van der Werf, G.R., Journal of Geophysical Research - Atmospheres, 2008, 113, D9, D09301
- **Climate Processes Using AIRS**
  - Atmosphere-ocean conditions jointly guide convection of the Boreal Summer Interseasonal Oscillation: Satellite Observations, Yang, B., Fu, X., Wang, B., J. Geophys.Res., 113, D11105, doi: 10.1029/2007JD009276
  - An assessment of the tropical humidity-temperature covariance using AIRS, Gambacorta, A., Barnet, C., Soden, B., Strow, L., Geophys.Res.Lett. 2008, 35, 10, L10814
- **Three CO2 Papers Published**
  - M. T. Chahine, Luke Chen, Paul Dimotakis, Xun Jiang, Qinbin Li, Edward T. Olsen, Thomas Pagano, James Randerson, and Yuk L. Yung, "Satellite remote sounding of mid-tropospheric CO2", GRL VOL. 35, LXXXXX, doi:10.1029/2008GL035022, 2008.
  - L. Larrabee Strow and Scott E. Hannon, A 4-year zonal climatology of lower tropospheric CO2 derived from ocean-only Atmospheric Infrared Sounder observations Journal of Geophysical Research, accepted 29 May 2008; doi: 10.1029/2007JD009713, 2008
  - CO2 retrievals from the Atmospheric Infrared Sounder: Methodology and Validation, Maddy, E.S., Barnet, C.D., Goldberg, M., Sweeney, C., Liu, X, Journal of Geophysical Research - Atmospheres, 2008, 113, D11, D11105





AIRS CO
October
2006



AIRS CO_2
July 2007

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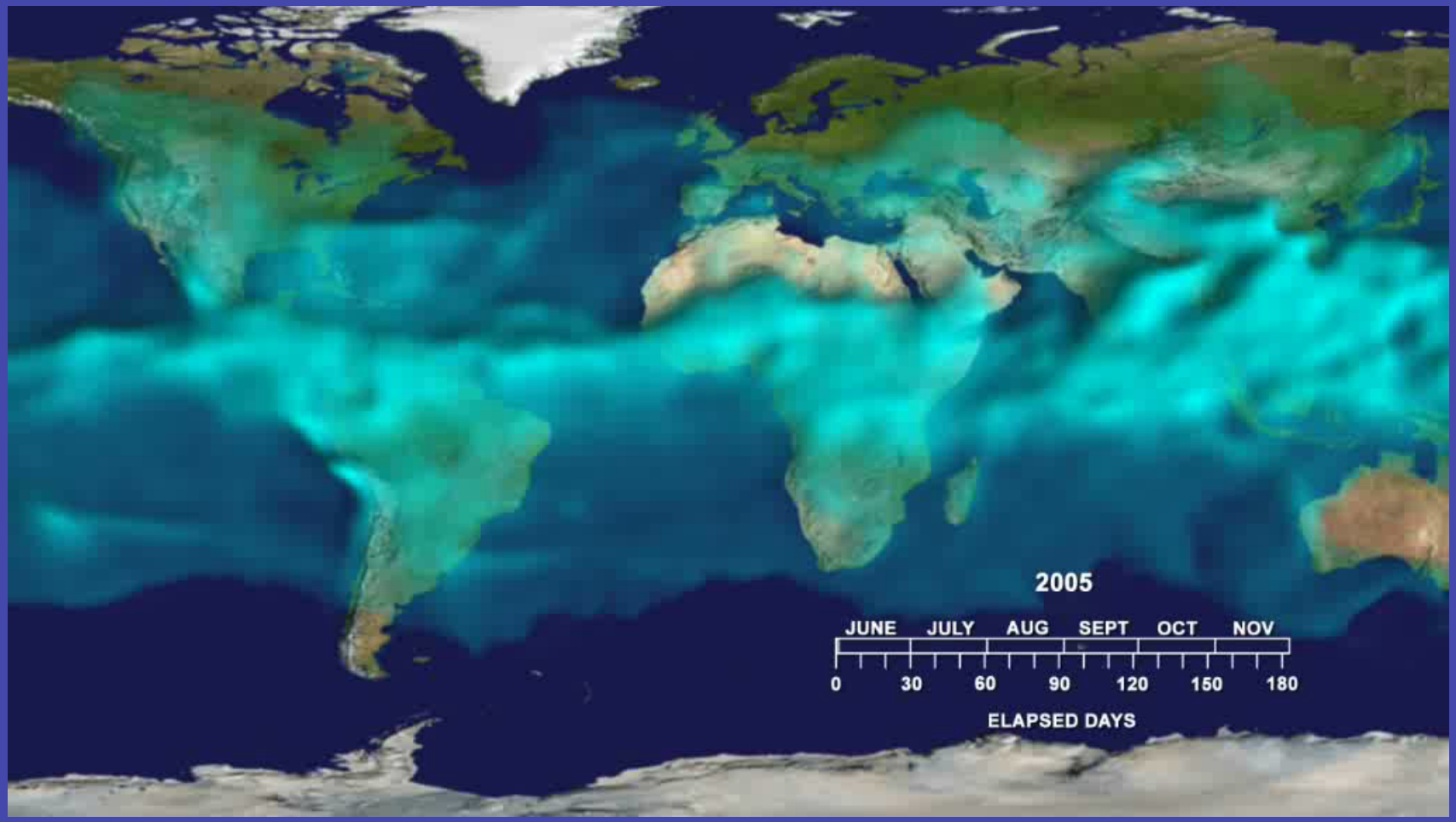
AIRS Water Vapor Isosurfaces
(Mass Mixing Ratio = 5 kg H2O/ kg Dry)



V. Realmuto, C. Thompson, T. Pagano, S. Ray NASA/
JPL

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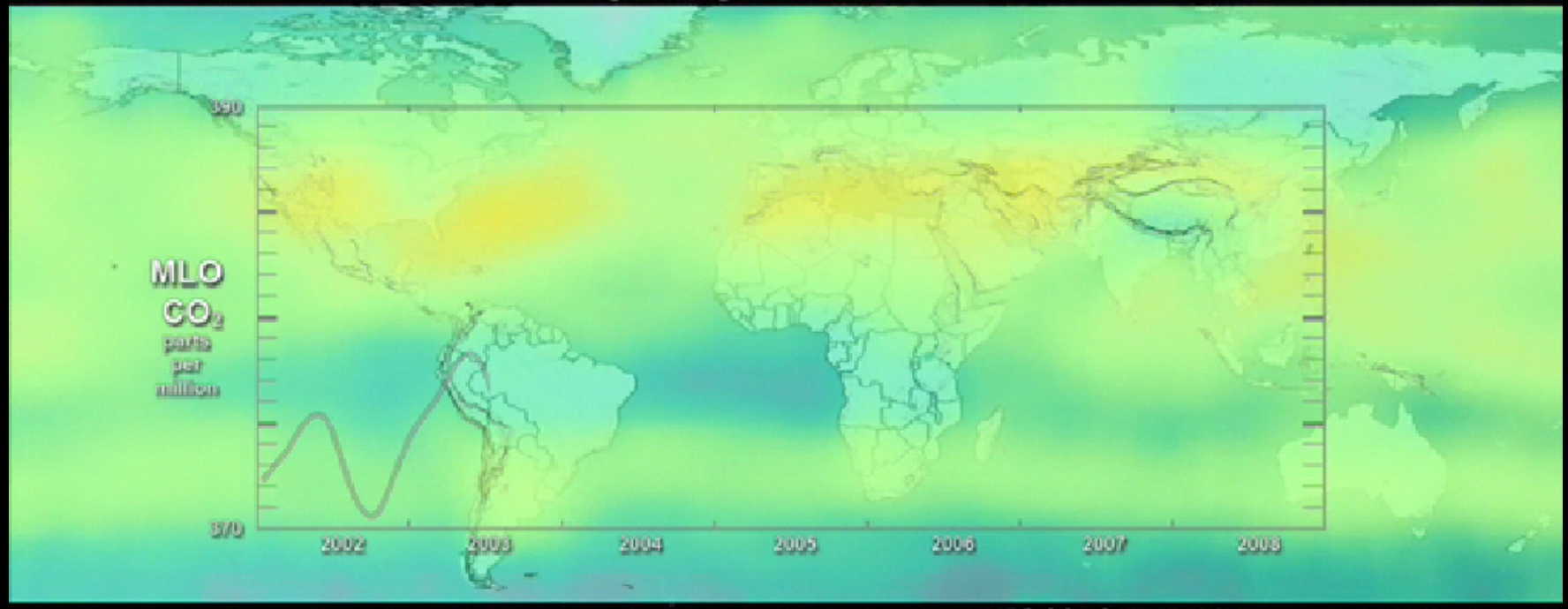
AIRS Mid-Tropospheric Carbon Dioxide



M. Chahine (JPL), L. Perkins (GSFC/SVS),
T. Pagano (JPL) , E. Olsen (JPL),

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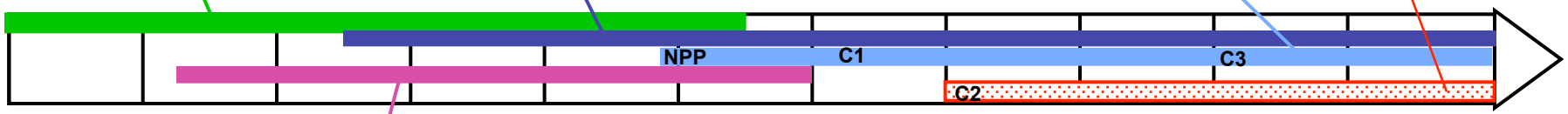
Long Term Climate Record Possible from Atmospheric Sounders!

AIRS
1:30 PM Orbit
14 km GSD
±49.5° Swath
Aqua: 2002

IASI
10:30 AM Orbit
12 km GSD
±49° Swath
MetOp 2007

CrIS
1:30 PM Orbit
14 km GSD
±48.3° Swath
NPP: 2010
C1: 2014 C3: 2020

NPOESS
5:30 AM
C2: 2016
CrIS De-Manifested

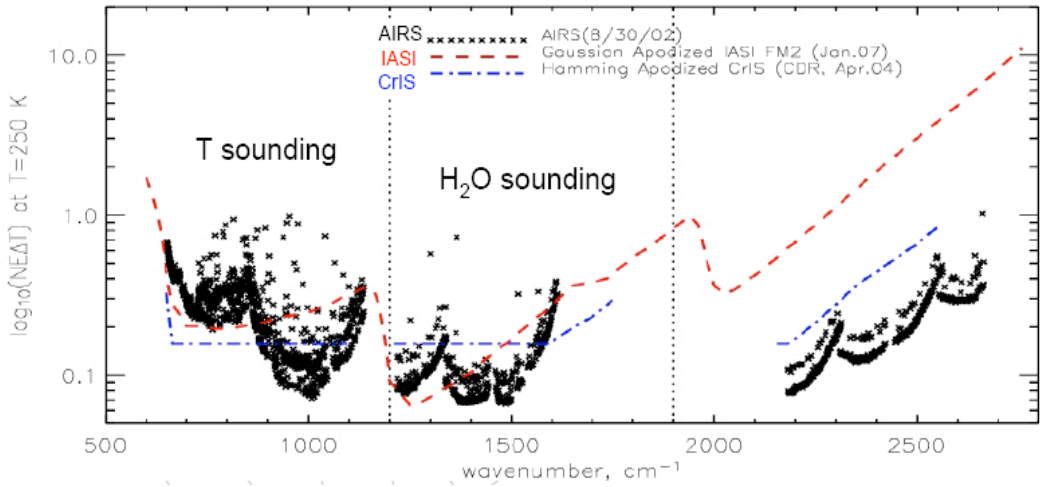


2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

TES on Aura
1:30 PM Orbit

Performance Comparable for AIRS, CrIS and IASI

Sounder NEdT Comparison



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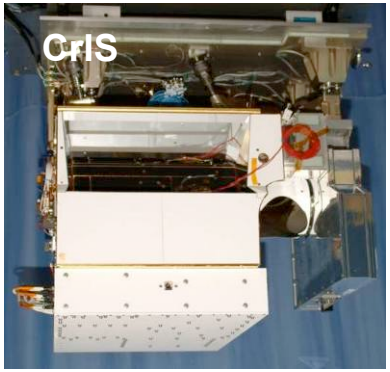
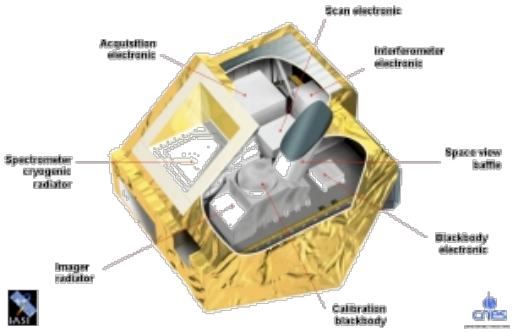
AIRS, CrIS, and IASI have Similar Features



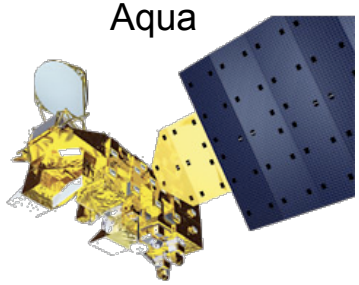
IASI

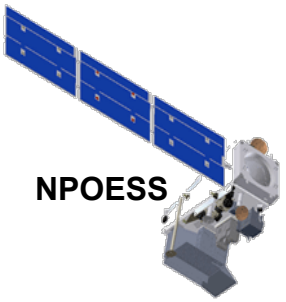


	AIRS	CrIS	IASI
Spectral Range (cm^{-1})	650-1140	650-1095	645-2760
	1210-1610	1210-1750	
	2170-2675	2155-2550	
Spectral Resolution (cm^{-1})	0.4-2.1	0.625-2.5 (Unapodized)*	0.35-0.5
Spatial Resolution	14 km	14 km	12 km
IFOV	3x3/1.1°	3x3/1.1°	2x2/1.1°
Size	0.9 m^3	0.5 m^3	1.7 m^3
Mass	177 kg	165 kg	236 kg
Power	256 W	135 W	210 W
Orbit Crossing Time	1:30 am/pm	1:30 am/pm	9:30 am/ pm

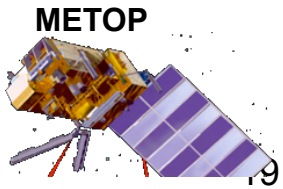
*Note: Unapodized Resolution about 2X lower than Apodized

Aqua





METOP



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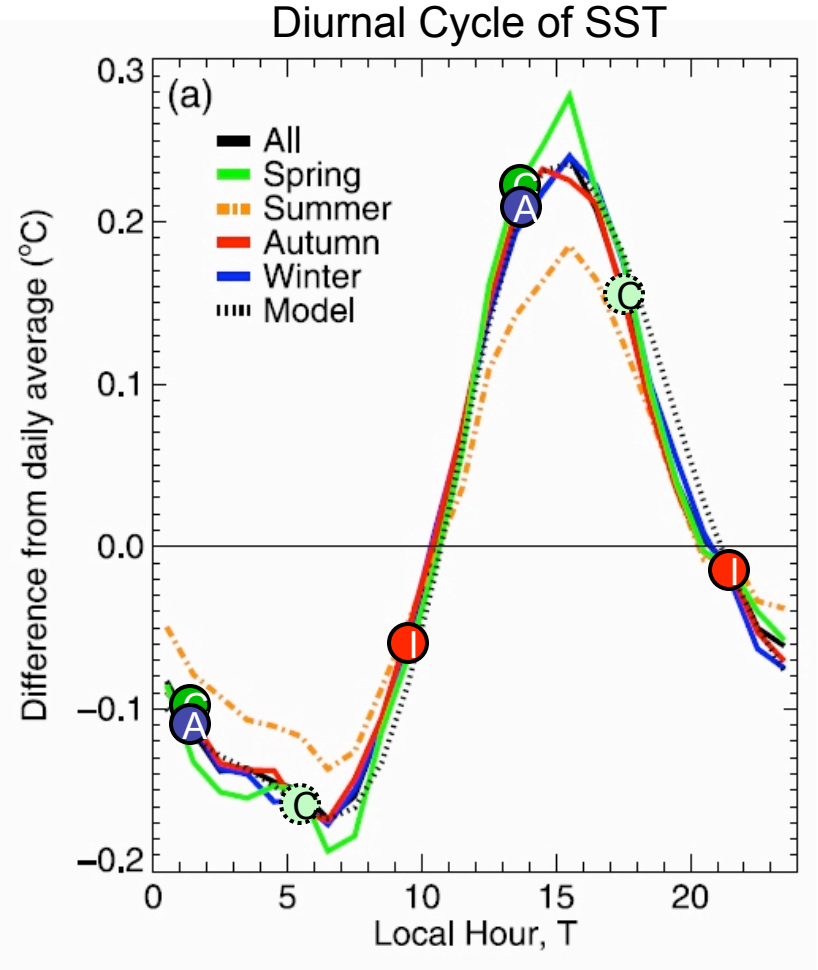
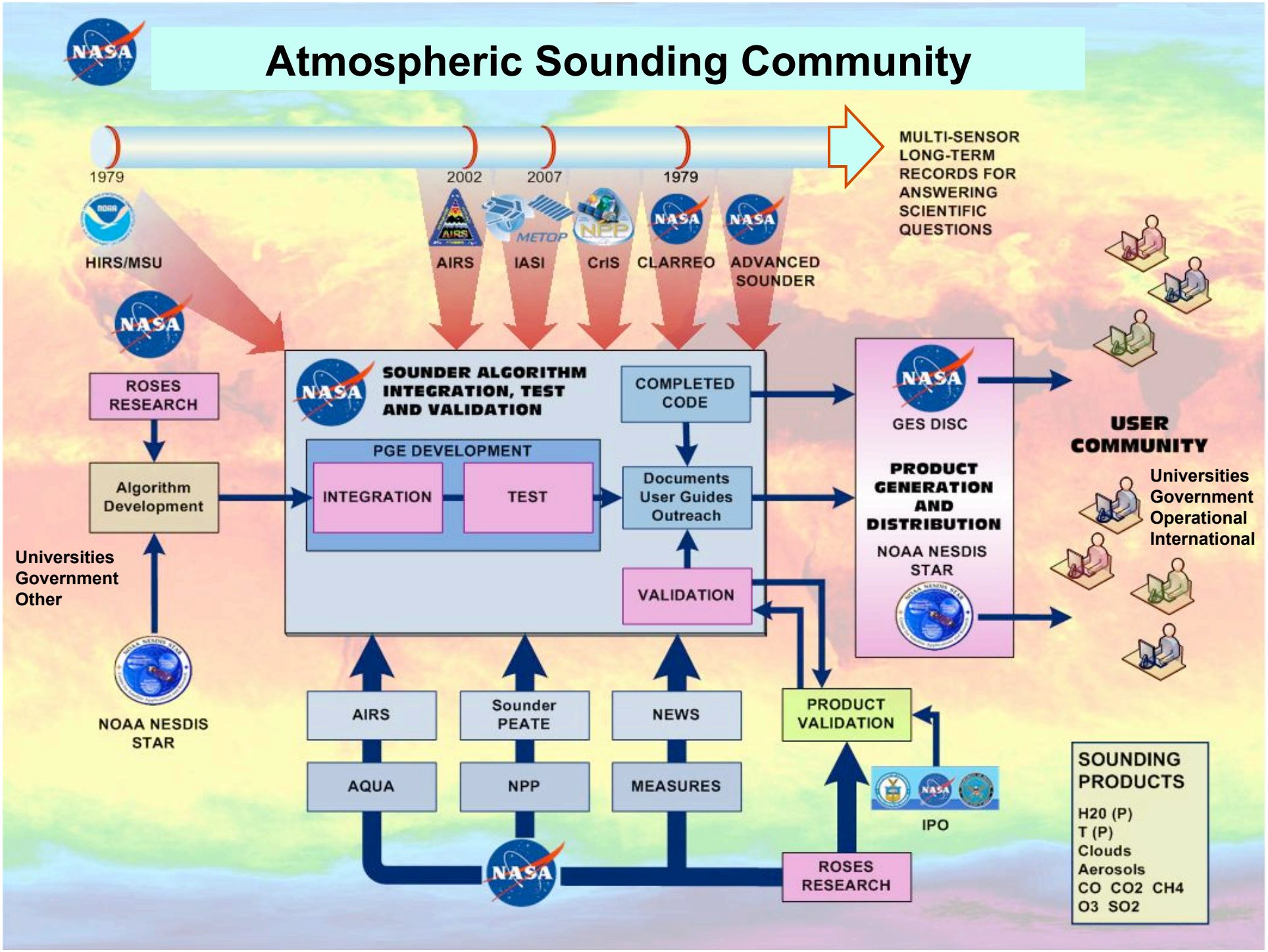
AIRS/CrIS and IASI Provide 4 Points in Diurnal Cycle

- AIRS: Aqua: 13:30, 1:30
- (A) TES: Aura: 13:30, 1:30
- (C) CrIS: NPOESS C1 and C3: 13:30, 1:30
- (I) IASI: MetOp, 9:30, 21:30
- (C) CrIS: NPOESS C2 (Demanifested): 5:30, 17:30

Recommendation made to "NRC Panel on Options to Ensure the Climate Record from the NPOESS and GOES-R Spacecraft" that loss of CrIS on C2 will impact ability to study diurnal cycle (June, 2007)



Atmospheric Sounding Community



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Conclusions

- AIRS Instrument and Aqua Spacecraft Healthy
- Science Discovery Continues
  - Improved forecast improvement
  - Climate Process and Model Validation
- Community very interested in AIRS data and continued improvement of the accuracy and resolution of the products
- AIRS, CrIS and IASI are complementary data sets for diurnal cycle and long-term observations of the atmosphere
- Integrating and coordinating cal/val and science activities will provide maximum benefit to all instrument teams and the science community